EFFECT OF DIFFERENT LEVELS OF *Lactobacillus plantarum* ON ORGANOLEPTIC, TOTAL PLATE COUNT (TPC), FAT, AND CHOLESTEROL CONTENT OF FERMENTED GOAT MEAT DENDENG

UNDERGRADUATE THESIS

By :

Desi Putri Natalena
SIN. 145050107111004

ANIMAL SCIENCE PROGRAM
FACULTY OF ANIMAL SCIENCE
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MALANG
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This Undergraduate-Thesis one of the terms of getting bachelor degree in Animal Science at Faculty of Animal Science Brawijaya University

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At this moment states in full that we are one group of the research about the addition of *Lactobacillus plantarum* on goat meat *dendeng* fermented.

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BIOGRAPHY

Desi Putri Natalena. The author was born on December 26th 1995 in Jakarta. The author is the second daughter from Ngatasi Tarigan and Saria Karosekali. Author's formal education started study on five years old in Widya Bhakti Kindergarten and continued to Widya Bhakti Elementary School. The author was graduated in 2008 and she continued her study in 16th Public Junior High School Bekasi (SMPN 16 Bekasi). In 2011, the author continued her study at 1st Public Senior High School Tambun Selatan (SMAN 1 Tambun Selatan). At that time, the author was active Student Internal Organisation (OSIS) as staff and vice president also English Club. In 2013, for a week, the author studied at Greenwood College, Perth, Western Australia and finished her study in 2014 and continued again for her bachelor degree in Animal Science Faculty in Brawijaya University.

During the time as college students, the author becomes one of members in English Class 2014. She has been joining some organisations such as Executive Council of Students in Animal Science Faculty as HRD staff in 2015. And then active in Christian Community of Animal Science Faculty. In 2017, the author joined Student Forum for Disability Care. She has been joining some commitees such as joined the event for welcoming new student (PKKMABA in 2015-2016 and PKKMU in 2016). Also in 2015-2016, the author joined christmas event for christian community. In 2017, the author became a leader of Grand Concert for Disability Awareness and she also joined assistant of practical work in animal product technology.

The author has done the internship at Bali Cattle-National Breeding Center (BPTU-HPT) at Denpasar in a month and now writing undergraduate thesis about research on goat *dendeng* obtained through fermentation with *Lactobacillus plantarum* in term to get the bachelor degree with the guidance of Prof. Dr. Ir. Lilik Eka Radiati, MS and Dr. Agus Susilo, S. Pt, MP

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The author also want to express his sincere thank to all of individual who has given the contribution for the writer. The authors would like to thanks to:

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EFFECT OF DIFFERENT LEVELS OF *Lactobacillus plantarum* ON ORGANOLEPTIC, TOTAL PLATE COUNT (TPC), FAT, AND CHOLESTEROL CONTENT OF FERMENTED GOAT MEAT DENDENG

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ABSTRACT

Goat meat processed to be IMF (Intermediate Moisture Food) would provide better nutrition value than before. The addition of Lactobacillus plantarum to the product would reduced cholesterol and fat also increased the shelf life. The purpose of research was to determine the effect of the addition of *Lactobacillus plantarum* on goat dendeng organoleptic (texture, aroma, and taste), TPC (Total Plate Count), cholesterol and fat content. The result could be used as information on the use of *Lactobacillus plantarum* in fermented meat product and obtained the best treatment of fermented goat meat *dendeng*. Materials used for this research were *dendeng* made from goat meat, spices, and *Lactobacillus plantarum.* The method used was Completely Randomized Design with four treatments and four replications, if there were significant effect would be followed with Duncan's Multiple Range Test. The result showed that *Lactobacillus plantarum* levels used in fermented goat meat dendeng had significant effect ($P<0.01$) on fat content 3.48 ± 0.70 – 7.83 ± 0.69, cholesterol content

75.65±0.69 – 79.06±0.41, and texture 2.74±1.06 – 3.18±1.10. the other result had significant effect (P<0.05) about aroma 3.07±1.07 – 3.43±1.09, and had no significant effect about taste 3.39±0.88 – 3.63±0.96 and Total Plate Count 4.95±0.21 – 6.34±0.56 log CFU/g. It was concluded that dendeng with 3 mL (T_2) *Lactobacillus plantarum* gave the best quality of fermented meat goat dendeng on organoleptic aspect and dendeng with 30 mL (T_3) *Lactobacillus plantarum* gave the best quality of fermented goat meat dendeng on non-organoleptic aspect.

Keywords: *fermentation, ground meat, lactic acid bacteria, sensory evaluation*

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SUMMARY

Goat meat is meat which had a paler color and white fat. This meat had high cholesterol and fat but not as high as beef or pork. Goat meat that proceed to be IMF (Intermediate Moisture Food) will gave better nutritional value. The addition of *Lactobacillus plantarum* that has ability to reduce the cholesterol and fat also increase the shelf life. It was effort to improve the quality of fermented goat dendeng. The purpose of this research were to determine the effect of *Lactobacillus plantarum* on fermented goat dendeng and to determine the best treatment of fermented goat dendeng. The result of can be used as information of *Lactobacillus plantarum* to make fermented goat dendeng.

Material that used was dendeng that made from goat meat, spices, and *Lactobacillus plantarum.* Method of this research was experimental method by used Completely Randomized Design with 4 treatments and 4 replications, consist of: 0 mL *Lactobacillus plantarum* (T_0), 0.3 mL *Lactobacillus plantarum* (T_1), 3 mL *Lactobacillus*

plantarum (T_2), and 30 mL *Lactobacillus plantarum* (T_3). Variable that observed were organoleptic (texture, aroma, and taste), Total Plate Count (TPC), cholesterol and fat content. Data analysis was used ANOVA (Analysis of Variance) and followed with Duncan's Multiple Range Test if there was significant effect.

The result showed that *Lactobacillus plantarum* levels used in fermented goat meat dendeng had significant effect ($P<0.01$) on fat content 3.48 ± 0.70 – 7.83 ± 0.69, cholesterol content 75.65 ± 0.69 – 79.06 ± 0.41, and texture 2.74 ± 1.06 – 3.18 ± 1.10. the other result had significant effect ($P<0.05$) about aroma 3.07 ± 1.07 – 3.43 ± 1.09, and had no significant effect about taste 3.39 ± 0.88 – 3.63 ± 0.96 and Total Plate Count 4.95 ± 0.21 – 6.34 ± 0.56 log CFU/g. Based on the result, it can be concluded that the best treatment obtained to treatment T_1 with addition 0.3 mL of *Lactobacillus plantarum* that had cholesterol content 77.16%, fat content 7.61%, Total Plate Count (TPC) 5.80 log CFU/g, texture 2.93, aroma 2.93, and taste 3.51. Suggestions to this research was for further research it can be done the fermentation with other culture on fermented goat meat dendeng and counted the population of microorganism before using the bulk starter.

TABLE OF CONTENTS

Content **Pages**

LIST OF TABLE(S)

LIST OF FIGURE(S)

Figure **Pages**

LIST OF APPENDIX(ES)

Appendix **Pages**

LIST OF ABBREVIATION(S)

mg	: milligram
g	: gram
±	: plus minus
℃	: degree celcius
cal	: calories
LDL	: Low Density Lipoprotein
pH	: potential hydrogen
mL	: mililitre
CFU	: Colony Forming Unit
mm	: milimeter
rpm	: rotation per minute
nm	: nanometer

CHAPTER I
INTRODUCTION

1.1. Background

Meat is a product of livestock, rich in nutrients such as proteins, minerals, fats, and other subtances needed by the body. As an animal protein source, meat has several benefits for human such as repairing damaged tissue, making natural antibodies, and also building muscle and bone. The meat produced from the livestock sector is not only chicken meat, but also lamb, beef, goat meat, and venison.

Goat meat is one of the most popular meat for people in Indonesia. This is caused by the taste and the price relatively affordable when compared with the beef. Some of people unable to consume meat due to the high fat and cholesterol. Development of meat processing technology needs to be done so the goat meat consumed by people can have good nutritional content for the body and can eliminate bad stigma from eating goat meat. Product that can be made from goat meat are meatball, satay, *dendeng*, and jerky.

Dendeng is sliced of meat from whole muscles that marinated and dried (Lim, Jung, Kim, Joo, and Yang, 2013) and has a unique taste. In fact, age and mindset of people affect the food that consumed by society. Simple and durable foods are an option for the community. *Dendeng* is one of the popular processed foods. But, meat production in Indonesia is still traditional to prevent the unwanted bacteria grow in the foods. This is what makes the water content decrease during the processing of *dendeng*. Protein, vitamins, and other subtances can be lost. Fermentation process was used to improve the nutritional content. Therefore, fermented *dendeng* is expected to improve the chemical and physical quality of the products and also

improve the safety and the shelf life. In addition, the bacteria will able to control the fermentation process in order to make a good change. One of the bacteria that can be used is *Lactobacillus plantarum*.

Lactobacillus plantarum is a lactic acid bacterium of the Lactobacilliceae family and the Lactobacillus genus. *Lactobacillus plantarum* bacteria are generally more resistant to acidic states. These bacteria are often used in the fermentation of milk, vegetables, and meat. The cholesterol in the meat will decrease by fermentation process. According to Sirilun, Chaiyasut, Kantachote, and Luxananil (2010), revealed the ability of *Lactobacillus plantarum* in lowering cholesterol reach 25.41%. Many research using beef in the manufacture of *dendeng* has been done, however research using goat meat have undone. The addition of *Lactobacillus plantarum* bacteria to fermented goat meat *dendeng* is expected to improve the quality of *dendeng* in terms of organoleptic, Total Plate Count (TPC), fat, and cholesterol level.

1.2. Problems

Based on the background could be formulated some problem

1. How is the effect of addition *Lactobacillus plantarum* to organoleptic aspect, microbe total, fat and cholesterol level on fermented goat meat *dendeng*?jerk
2. What is the best treatment of fermented goat meat *dendeng* based on the research?

1.3. Purposes

1. Determining the effect of addition *Lactobacillus plantarum* to organoleptic aspect, Total Plate Count (TPC), fat and cholesterol level on fermented goat meat *dendeng*

2. Determining the best treatment of fermented goat meat *dendeng* based on the research

1.4. Advantages

The advantages of this research is can be a new information and knowledge for people about the effect of *Lactobacillus plantarum* to goat meat *dendeng*.

1.5. Framework

Goat meat is a food that has higher efficacy that cattle and sheep. This meat very familiar in society because the unique texture and taste. But, most people have an opinion that goat meat has a high cholesterol and fat content that can trigger heart disease. Therefore, goat meat processing needs to be done to maintain nutrition and lower cholesterol also fat. Goat meat can be used as intermediate moisture food (IMF), which is a food that has a water content between 15-50%. One of the intermediate moisture food products is *dendeng*. Dendeng would be fermented with lactic acid bacteria to lower the cholesterol and fat.

The previous research by Nisa and Wardani (2016) stated fermented catfish sausages with *Lactobacillus plantarum* was given significant effect to the fat content. The fat content decreased to <10%. The result of aroma was significant because there was maillard reaction that produce aroma compound from furfural and maltol. The other research by Purnamasari, Nurhasni, and Zain (2012) concluded that soaking goat dendeng with betel leaf juice react uneffectively to the fat content that tends to increase.

Isolated *Lactobacillus plantarum* from cow milk by Amutha and Kokila (2015) showed that as one of lactic acid bacteria, it could be a potential probiotic with cholesterol-lowering effect. According to Yu, Zhang, Li, Li, Li, and

Yang (2012) explained that evaluation of probiotic properties of isolated *Lactobacillus plantarum* strains S2-5 and S4-1 from Chinese sauerkraut had capability of reducing cholesterol content. Research by Arief, Suryati, and Maheswari (2006) explained that fermentation with *Lactobacillus plantarum* in beef Dark Firm Dry (DFD) obtained a tender meet better than natural fermentation.

Lactobacillus plantarum is one of lactic acid bacteria which has beneficial properties. These bacteria are often used in the fermentation of foods, such as milk, meat, and vegetables. The fermentation process with *Lactobacillus plantarum* in a product can increase lactic acid activity causing inhibition of pathogen. Then, *Lactobacillus plantarum* can also reduce cholesterol and fat in the body and food product. *Lactobacillus plantarum* can be added to goat dendeng in order to improve organoleptic quality, Total Plate Count (TPC), and decrease cholesterol and fat.

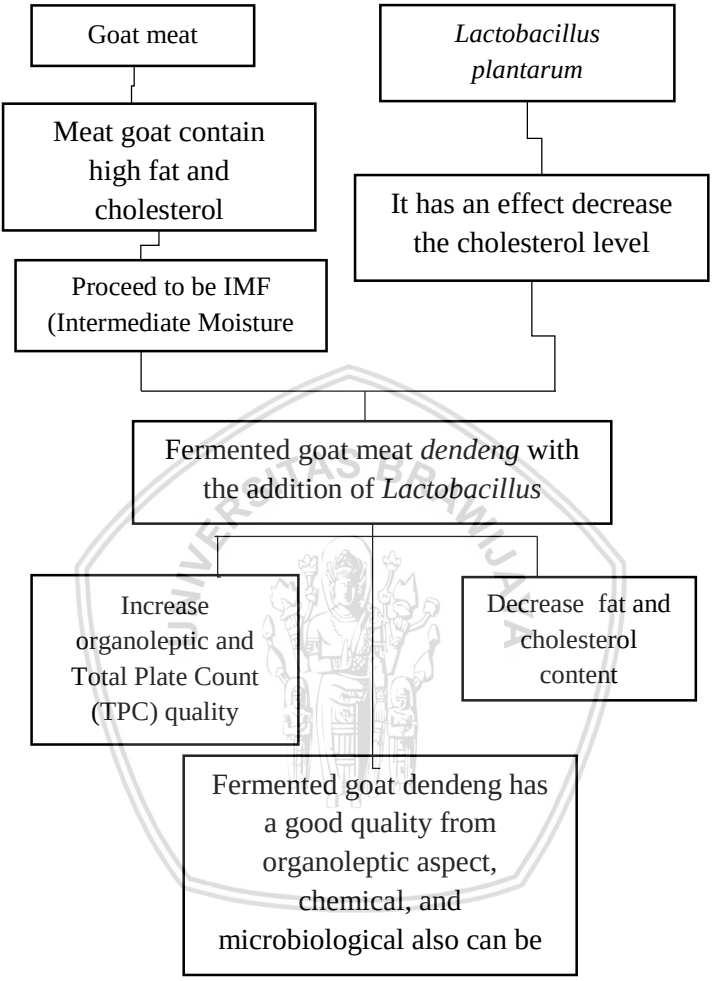

Figure 1. Framework

1.6. Hypothesis

The hypothesis of this research are:

H_0 : Addition of *Lactobacillus plantarum* does not give significant effect for organoleptic aspect, Total Plate Count (TPC), cholesterol and fat level of fermented goat *dendeng*.

H_1 : Addition of *Lactobacillus plantarum* give significant effect for organoleptic aspect, Total Plate Count (TPC), cholesterol and fat level of fermented goat *dendeng.*

CHAPTER II
LITERATURE REVIEW

2.1. Meat

Meat is one of food that have high nutritional value because it contain high quality protein also vitamin B complex and minerals (Veerman, Setiyono, and Rusman 2013). Beside that, meat also has high biological value, nutritional conetent is easily digested and absorbed by the body. The consumption of meat and its products has increased from year to year (Evanuarini and Huda, 2011). Meat is a source of animal protein that have high nutriona value compared with vegetable protein because it contain complete and balance amino acids, fats, minerals, and vitamins that needed by the body also has high digestibility and easily absorbed. Meat is a product that easily damaged, then one way to overcome it is to turn into another product, that is jerky (Febrianingsih, Hafid, and Ningsih, 2016).

2.2. Goat meat

Goat meat is liked by community because it is easy to get, easy to process, and also many variations of cooking can be made. Goat meat is cheaper compared with beef. It has a very good nutrient contents for the human body such as iron, potassium, and high thiamine (Afid and Nurmasitoh, 2016). Cholesterol in goat meat have a risk can blockage of blood vessels when consumed in excess. It is necessary to develop a method to reduce the cholesterol level, so it is safer to consume (Nuansa and Istiyanti, 2013).

Goat meat has a distintive feature, that is almost no fat under the skin, excess of fat is dumped as fat that spread among the meat fibers. The composition of carcass consist of meat 62%, bone 19%, and fat 19%. Nutrional content of

goat meat per 100 g of ingredients are water (70.3 g), protein (16.6 g), fat (9.2 g), calcium (11 mg), phosphorus (124 mg), iron (1.0 mg), vitamin B1 (0.09 mg), and calories (154 cal) (Tiven, Suryanto, and Rusman, 2007).

2.3. Dendeng

Dendeng is one of meat products that have been widely known by the people of Indonesia, can be made from beef, chicken, pork, goat, and duck (Pursudarsono, Rosyidi, and Widati, 2015). *Dendeng* is food product in the form of slab from slices, grind, or frozen fresh meat that has been marinated and dried. *Dendeng* is usually served by frying (Kosim, Suryati, and Gunawan, 2015). Traditional product from meat are the result of combination of marinating and drying process. Preparation of *dendeng* is one of alternative food prcocessing so the shelf life would relatively longer, with water content of 20-40%. The seasoning for marinated are salt, sugar as main ingredients, while pepper, galangal, coriander, and garlic are additional ingredients that can increase the *dendeng* palatability (Veerman, et.al 2013). Standar of beef dendeng presented on Table 1.

Table 1. Criteria of Beef Dendeng(SNI 2908: 2013)

No.	Criteria	Unit	Requirement
1	Aroma	-	Typical beef dendeng
2	Color	-	Typical beef dendeng
3	Water Content	%	Max. 12
4	Protein Content	%	Min. 18
5	Fat Content	%	Max. 3
6	Timbel	%	Max 1.0
7	Tin	%	Max 40.0
8	Mercury	%	Max. 0.03

Source: Bandar Standarisasi Nasional (2013)

2.3.1. Salt

According to Subiyantoro (2001), salt is white solid crystallater, with most composed of Sodium Chloride compounds (>80%) and the other compounds such us Magnesium Chloride, Magnesium Chloride, Magnesium Sulphate, and Calcium Chloride. It has hydroscopic characteristic which means easy to absorb water, density level of 0.8 to 0.9 and melting point at a temperature level of 801℃. Salt is one of the most frequently used ingredients in meat product. Salt affects the flavor and texture of meat products. It brings out the characteristic taste of the meat product (Lim, et. al 2013). Salt is a chemical component with bacteriostatic and bacteriocidal character. Bacteria can be destroyed by salt because of its hygroscopic character that can absorb water (cytoplasm) bacteria. Ion Na^+ and Cl^- on salt are also toxin for some bacteria (Salosa, 2013).

2.3.2. Palm Sugar

Palm sugar or also called brown sugar is made by heating the sap into a liquid which then after cooled to form fine crystals (*gula semut*) or printed into sugar beams (Soeseno, 1993). The formation of palm sugar to obtained brown color is from Maillard's reaction that produce compounds that has antioxidant characteristic. (Iijima, Nakazawa, Watanabe, and Yoshimura, 1997). The brown color of palm sugar contain dietary fiber that is beneficial for digestive health. There are also compounds that inhibit the absorption of cholesterol in digestive tract (Baehak, Syukroni, and Yuliati, 2013). Chemical composition of palm sugar per 100 grams are: phospor 35 mg, calsium 75 mg, Fe 3 mg, water content 9 grams, and energy 368 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.3.3. Galangal (*Alpinia galanga* L.)

Galangal (*Alpinia galanga L.)* is from Zingiberaceae family. The galanga rhizome is easily obtained in Indonesia. It has been used as one of the spices for years and has never caused any problems (Handajani and Purwoko, 2008). Research by Nurbalatif, Eryanti, and Yuharmen (2002) showed there is inhibition activity of microbial growth by volatile oil and methanol fraction of galangal rhizomes in several species of bacteria and fungi. According to Sundari and Winarno (2000) showed the infusion of ethanol extract of galangal rhizome containing essential oils can inhibit the growth of several species of pathogenic fungi, such as Tricophyton, Mycrosporum gypseum, and Epidermo floccasum. Food that use galangal will have a resistance to the growth of mushrooms (Hernani, Marwati, and Winarti, 2007). The active compounds found in *Alphinia galanga* were β-bisabolene, β-farnesene, 1,8-cineol, α-fenchyl acetate, α-bergamotene, β-pinene and 1'-acetoxychavicol acetate (Subramanian and Nishan, 2015)

2.3.4. Cumin

White cumin seeds are one of the most widely herbs that usually used as spices for cooking. The essential oil from white cumin seeds is reported have the ability as an antimicrobial compound that against phatogenic. (Lacobellis, Lo Cantore, Capasso, and Senatore, 2005). According to Jenie, Djuwita, and Sjamsuridzal (2011), essential oils of white cumin also contain hydrocarbon compounds, hydrophilic cuminaldehyde, that has ability to inhibit the fungi to be more effective. The composition of cumin seeds were >5% of volatile oil, 22% fats, numerous

free amino acids and flavonoid glycosides (Kaur and Sharma, 2012)

2.3.5. Garlic

Garlic (*Allium sativum* L.) has an antioxidant effect that has function to prevent the occurence of LDL oxidation which is the way of cholesterol formation. One of the most powerful anticholesterol subtances in garlic is Ajoene. Ajoene is an unsaturated disulfide form from 3 (three) binding allicin molecules, allicin is a sulphinyl compound which give a strong aroma to garlic (Thohari, Susrinil, and Yuniar, 2007). Garlic can increase cardiovascular function because it can maintain hypercholesterolemic attacks and artherosclerosis. Free radicals are major cause of these disease. Antioxidants seem to be able prevent the free radical (Prasad, Laxdal, Yu and Raney, 1996). In Indonesia, garlic also potential to used as antimicrobial agents. Its ability to inhibit the growth of microbes including viruses bacteria, protozoa, and fungi (Hernawan and Setyawan, 2003). Chemical composition of local garlic bulb per 100 grams are: protein 4.5 grams, fat 0.2 gram, carbohydrate 23.10 grams, vitamin B1 0.22 mg, vitamin C 15 mg, phospor 134 mg, calsium 42 mg, Fe 1 mg, water content 71 grams, and energy 95 calories (BPPT, 2006)

2.3.6. Coriander

Coriander, like many spices, contains antioxidants, which can prevent the spoilage of food seasoned. In the food industry, coriander is approved for food used by the US Food and Drug Administration, the Flavor and Extract Manufacturers Association and the Council of Europe, and the plant can be used as spice, a raw material in food, beverage and pharmaceutical industries. (Mandal and

Mandal, 2015) Chemical composition of coriander per 100 grams are: fat 16.10 grams, phospor 370 mg, calsium 630 mg, Fe 17.90 mg, water content 11.20 grams, vitamin A 1570 mg, vitamin B1 0.20 mg, and energy 404 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.3.7. Pepper

Pepper (*Piper nigrum* L.) is from Piperaceae family (Vasavirama dan Upender, 2014). White pepper is obtained from black pepper whose fruits are picked while still green or almost ripe, then soaked to facilitated stripping the outer layer of pericarp, then dried (Kartasapoetra, 2004). Pepper also called as King of Spices, considering that in addition as flavor, pepper has many various benefits of human life. Piperin may act as an antibacterial that can inhibit the development of *Staphylococcus aureus*, *Bacillus cereus*, and *Eschericia coli* (Wahyudi, 2011). Chemical composition of pepper per 100 grams are: vitamin B1 0.20 mg, phospor 200 mg, calsium 460 mg, Fe 16.80 mg, water content 12.90 grams, fat 6.80 grams and energy 359 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.4. Fermentation

Fermentation is an aerobic or anaerobic process that produced various products can increase microbial activity, decreased pH, and increase acid levels of fermented products. Fermentation process result increased microbial activity, acid level and decreased pH (Afriani, 2010). The fermentation process requires microbes as an inoculum, a thing to ensure the optimal process and substrate as medium and a source of microbe nutrition (Waites, Morgan, Rockey,

and Highton, 2001). According to Mulyanto (1992) fermentation is process of decomposing compounds from complex ingredients into simple compounds at controlled state. According to Azizah, Al-Baarri, and Mulyani (2012) there are many factors which influenced fermentation such as substrate, temperature, pH, oxygen, and microbe that used.

2.5. Lactic Acid Bacteria

Lactic acid bacteria is one of microbes, have a function on fermentation process and produces antimicrobial compound that can inhibit the growth of pathogen and rancidity bacteria in the foodstuffs so it can extend the shelf life of products (Ahmad, Nofiani, and Ardiningsih, 2013). Lactic acid bacteria capable to produce many compound which give spesific flavor and aroma to fermented food (Purwandhani and Rahayu, 2001)

2.6. *Lactobacillus plantarum*

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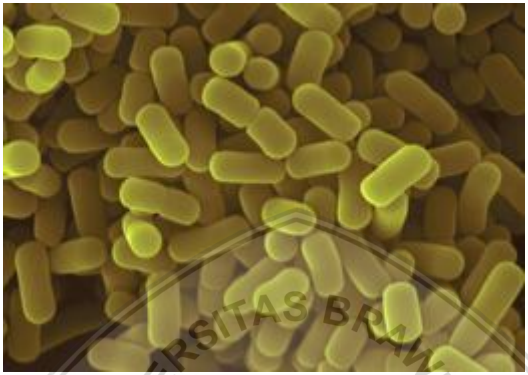

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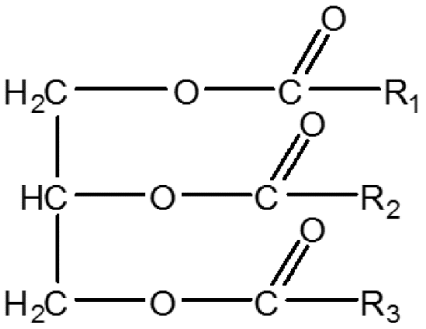

Figure 3. Fat Molecules (Pomeranz and Meloan, 2000) with modification)

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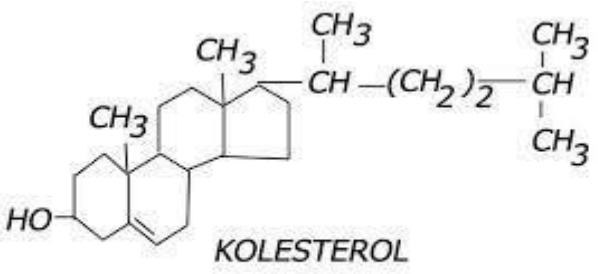

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Nisa and Wardani (2016) stated that fermented sausage of catfish (*Clarias gariepinus*) with the addition of *Lactobacillus plantarum* has decreased the fat content of the product because of the affect of activity of secondary lipolytic in the lactic acid. This activity could break down fat into simple chemical compound. Lipase enzyme controlled the lipolytic activity in order to released fatty acids. According to Tok and Belma (2010) if the cells dead because it was heated, it still could remove cholesterol from the medium by binding the cholesterol to cell. Some of microbes could produce compound that could inhibited, mobilized, and reduced the cholesterol content (Brown and Goldstein, 1991). Sour taste from lactic acid was the final product of carbohydrate metabolism by lactic acid bacteria (Setyorini, Arifin, and Nurwantoro, 2010)

CHAPTER II
LITERATURE REVIEW

2.1. Meat

Meat is one of food that have high nutritional value because it contain high quality protein also vitamin B complex and minerals (Veerman, Setiyono, and Rusman 2013). Beside that, meat also has high biological value, nutritional conetent is easily digested and absorbed by the body. The consumption of meat and its products has increased from year to year (Evanuarini and Huda, 2011). Meat is a source of animal protein that have high nutriona value compared with vegetable protein because it contain complete and balance amino acids, fats, minerals, and vitamins that needed by the body also has high digestibility and easily absorbed. Meat is a product that easily damaged, then one way to overcome it is to turn into another product, that is jerky (Febrianingsih, Hafid, and Ningsih, 2016).

2.2. Goat meat

Goat meat is liked by community because it is easy to get, easy to process, and also many variations of cooking can be made. Goat meat is cheaper compared with beef. It has a very good nutrient contents for the human body such as iron, potassium, and high thiamine (Afid and Nurmasitoh, 2016). Cholesterol in goat meat have a risk can blockage of blood vessels when consumed in excess. It is necessary to develop a method to reduce the cholesterol level, so it is safer to consume (Nuansa and Istiyanti, 2013).

Goat meat has a distintive feature, that is almost no fat under the skin, excess of fat is dumped as fat that spread among the meat fibers. The composition of carcass consist of meat 62%, bone 19%, and fat 19%. Nutrional content of

goat meat per 100 g of ingredients are water (70.3 g), protein (16.6 g), fat (9.2 g), calcium (11 mg), phosphorus (124 mg), iron (1.0 mg), vitamin B1 (0.09 mg), and calories (154 cal) (Tiven, Suryanto, and Rusman, 2007).

2.3. Dendeng

Dendeng is one of meat products that have been widely known by the people of Indonesia, can be made from beef, chicken, pork, goat, and duck (Pursudarsono, Rosyidi, and Widati, 2015). *Dendeng* is food product in the form of slab from slices, grind, or frozen fresh meat that has been marinated and dried. *Dendeng* is usually served by frying (Kosim, Suryati, and Gunawan, 2015). Traditional product from meat are the result of combination of marinating and drying process. Preparation of *dendeng* is one of alternative food prcocessing so the shelf life would relatively longer, with water content of 20-40%. The seasoning for marinated are salt, sugar as main ingredients, while pepper, galangal, coriander, and garlic are additional ingredients that can increase the *dendeng* palatability (Veerman, et.al 2013). Standar of beef dendeng presented on Table 1.

Table 1. Criteria of Beef Dendeng(SNI 2908: 2013)

No.	Criteria	Unit	Requirement
1	Aroma	-	Typical beef dendeng
2	Color	-	Typical beef dendeng
3	Water Content	%	Max. 12
4	Protein Content	%	Min. 18
5	Fat Content	%	Max. 3
6	Timbel	%	Max 1.0
7	Tin	%	Max 40.0
8	Mercury	%	Max. 0.03

Source: Bandar Standarisasi Nasional (2013)

2.3.1. Salt

According to Subiyantoro (2001), salt is white solid crystallater, with most composed of Sodium Chloride compounds (>80%) and the other compounds such us Magnesium Chloride, Magnesium Chloride, Magnesium Sulphate, and Calcium Chloride. It has hydroscopic characteristic which means easy to absorb water, density level of 0.8 to 0.9 and melting point at a temperature level of 801℃. Salt is one of the most frequently used ingredients in meat product. Salt affects the flavor and texture of meat products. It brings out the characteristic taste of the meat product (Lim, et. al 2013). Salt is a chemical component with bacteriostatic and bacteriocidal character. Bacteria can be destroyed by salt because of its hygroscopic character that can absorb water (cytoplasm) bacteria. Ion Na^+ and Cl^- on salt are also toxin for some bacteria (Salosa, 2013).

2.3.2. Palm Sugar

Palm sugar or also called brown sugar is made by heating the sap into a liquid which then after cooled to form fine crystals (*gula semut*) or printed into sugar beams (Soeseno, 1993). The formation of palm sugar to obtained brown color is from Maillard's reaction that produce compounds that has antioxidant characteristic. (Iijima, Nakazawa, Watanabe, and Yoshimura, 1997). The brown color of palm sugar contain dietary fiber that is beneficial for digestive health. There are also compounds that inhibit the absorption of cholesterol in digestive tract (Baehak, Syukroni, and Yuliati, 2013). Chemical composition of palm sugar per 100 grams are: phospor 35 mg, calsium 75 mg, Fe 3 mg, water content 9 grams, and energy 368 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.3.3. Galangal (*Alpinia galanga* L.)

Galangal (*Alpinia galanga L.)* is from Zingiberaceae family. The galanga rhizome is easily obtained in Indonesia. It has been used as one of the spices for years and has never caused any problems (Handajani and Purwoko, 2008). Research by Nurbalatif, Eryanti, and Yuharmen (2002) showed there is inhibition activity of microbial growth by volatile oil and methanol fraction of galangal rhizomes in several species of bacteria and fungi. According to Sundari and Winarno (2000) showed the infusion of ethanol extract of galangal rhizome containing essential oils can inhibit the growth of several species of pathogenic fungi, such as Tricophyton, Mycrosporum gypseum, and Epidermo floccasum. Food that use galangal will have a resistance to the growth of mushrooms (Hernani, Marwati, and Winarti, 2007). The active compounds found in *Alphinia galanga* were β-bisabolene, β-farnesene, 1,8-cineol, α-fenchyl acetate, α-bergamotene, β-pinene and 1'-acetoxychavicol acetate (Subramanian and Nishan, 2015)

2.3.4. Cumin

White cumin seeds are one of the most widely herbs that usually used as spices for cooking. The essential oil from white cumin seeds is reported have the ability as an antimicrobial compound that against phatogenic. (Lacobellis, Lo Cantore, Capasso, and Senatore, 2005). According to Jenie, Djuwita, and Sjamsuridzal (2011), essential oils of white cumin also contain hydrocarbon compounds, hydrophilic cuminaldehyde, that has ability to inhibit the fungi to be more effective. The composition of cumin seeds were >5% of volatile oil, 22% fats, numerous

free amino acids and flavonoid glycosides (Kaur and Sharma, 2012)

2.3.5. Garlic

Garlic (*Allium sativum* L.) has an antioxidant effect that has function to prevent the occurence of LDL oxidation which is the way of cholesterol formation. One of the most powerful anticholesterol subtances in garlic is Ajoene. Ajoene is an unsaturated disulfide form from 3 (three) binding allicin molecules, allicin is a sulphinyl compound which give a strong aroma to garlic (Thohari, Susrinil, and Yuniar, 2007). Garlic can increase cardiovascular function because it can maintain hypercholesterolemic attacks and artherosclerosis. Free radicals are major cause of these disease. Antioxidants seem to be able prevent the free radical (Prasad, Laxdal, Yu and Raney, 1996). In Indonesia, garlic also potential to used as antimicrobial agents. Its ability to inhibit the growth of microbes including viruses bacteria, protozoa, and fungi (Hernawan and Setyawan, 2003). Chemical composition of local garlic bulb per 100 grams are: protein 4.5 grams, fat 0.2 gram, carbohydrate 23.10 grams, vitamin B1 0.22 mg, vitamin C 15 mg, phospor 134 mg, calsium 42 mg, Fe 1 mg, water content 71 grams, and energy 95 calories (BPPT, 2006)

2.3.6. Coriander

Coriander, like many spices, contains antioxidants, which can prevent the spoilage of food seasoned. In the food industry, coriander is approved for food used by the US Food and Drug Administration, the Flavor and Extract Manufacturers Association and the Council of Europe, and the plant can be used as spice, a raw material in food, beverage and pharmaceutical industries. (Mandal and

Mandal, 2015) Chemical composition of coriander per 100 grams are: fat 16.10 grams, phospor 370 mg, calsium 630 mg, Fe 17.90 mg, water content 11.20 grams, vitamin A 1570 mg, vitamin B1 0.20 mg, and energy 404 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.3.7. Pepper

Pepper (*Piper nigrum* L.) is from Piperaceae family (Vasavirama dan Upender, 2014). White pepper is obtained from black pepper whose fruits are picked while still green or almost ripe, then soaked to facilitated stripping the outer layer of pericarp, then dried (Kartasapoetra, 2004). Pepper also called as King of Spices, considering that in addition as flavor, pepper has many various benefits of human life. Piperin may act as an antibacterial that can inhibit the development of *Staphylococcus aureus*, *Bacillus cereus*, and *Eschericia coli* (Wahyudi, 2011). Chemical composition of pepper per 100 grams are: vitamin B1 0.20 mg, phospor 200 mg, calsium 460 mg, Fe 16.80 mg, water content 12.90 grams, fat 6.80 grams and energy 359 calories (Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly, 2009)

2.4. Fermentation

Fermentation is an aerobic or anaerobic process that produced various products can increase microbial activity, decreased pH, and increase acid levels of fermented products. Fermentation process result increased microbial activity, acid level and decreased pH (Afriani, 2010). The fermentation process requires microbes as an inoculum, a thing to ensure the optimal process and substrate as medium and a source of microbe nutrition (Waites, Morgan, Rockey,

and Highton, 2001). According to Mulyanto (1992) fermentation is process of decomposing compounds from complex ingredients into simple compounds at controlled state. According to Azizah, Al-Baarri, and Mulyani (2012) there are many factors which influenced fermentation such as substrate, temperature, pH, oxygen, and microbe that used.

2.5. Lactic Acid Bacteria

Lactic acid bacteria is one of microbes, have a function on fermentation process and produces antimicrobial compound that can inhibit the growth of pathogen and rancidity bacteria in the foodstuffs so it can extend the shelf life of products (Ahmad, Nofiani, and Ardiningsih, 2013). Lactic acid bacteria capable to produce many compound which give spesific flavor and aroma to fermented food (Purwandhani and Rahayu, 2001)

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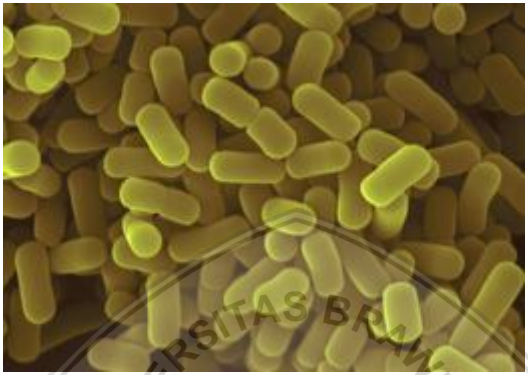

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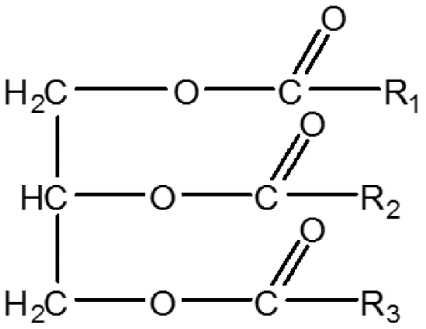

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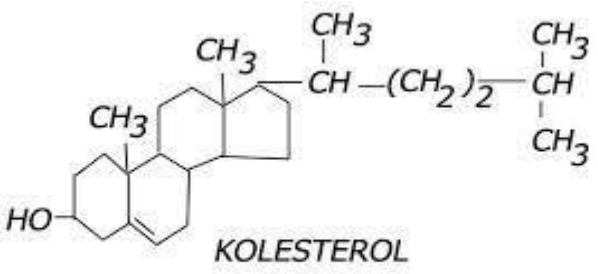

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CHAPTER III
MATERIALS AND METHODS

3.1. Location and Time

The research was conducted from November 2017 to January 2018 located in: The process of making fermented goat meat *dendeng* was conducted in the egg laboratory, Animal Product Technology Department, Faculty of Animal Science, Brawijaya University. The analysis of Total Plate Count (TPC) and propagation of *Lactobacillus plantarum* was conducted in the microbiology laboratory Animal Product Technology Department, Faculty of Animal Science, Brawijaya University. The analysis of fat level was conducted in the psychochemical laboratory, Animal Product Technology Department, Faculty of Animal Science, Brawijaya University. The analysis of sensory evaluation was conducted in Faculty of Animal Science, Brawijaya University. The analysis of cholesterol level was conducted in Math and Natural Science Laboratory, Padjajaran University.

3.2. Materials

3.2.1. Material of research

The main ingredients to make fermented goat meat *dendeng* was the thigh of goat meat obtain from *kambing kacang (Capra hircus)* aged from 1 – 2 years which was purchased from Kebalen Traditional Market, Zaenal Zakse street, Malang. Next, goat meat grinded at Tawangmangu Traditional Market, Lowokwaru district, Malang. The other ingredients were palm sugar, garlic, coriander, galangal, cumin, salt, and pepper and added with *Lactobacillus plantarum* FNCC (Food and Nutrition Culture Collection) 0027 that propagated with *deMan Rogosa Sharp Agar* (MRS-A), *deMan Rogosa Sharp Broth* (MRS-B), skimmed milk, and sugar. Material analysis were petroleum ether for fat content; PWB (Peptone Water Buffered), PCA (Plate Count Agar) for Total Plate Count (TPC); and alcohol, ether,

acetic acid anhydride, chloroform blanko, and concentrated sulfuric acid for cholesterol content.

3.2.2 Equiptment

The equipment that used for making fermented goat meat *dendeng* were *dendeng* mold (thick glass 3 (three) milimeters, plastic gloves food grade, aluminium foil, bread paper, analytical scale with accuracy 0.01 gram, spoon, solet, basin, oven. Equipment for propagation of *Lactobacillus plantarum* FNCC 0027 were erlenmeyer 200 ml, petri dish, reaction tube with the rack, incubator, autoclave, ose wire, and pippete. Equipment for analysis were filter paper, oven, ecsicator, analytical balance, and cotton for fat content; erlenmeyer, reaction tube, petri dish,, micropippete, and beaker glass for Total Plate Count (TPC); centrifuge, beaker glass and test tube for cholesterol content; paper, pen, and samples for organoleptic.

3.3. Method

The method was experimental design with one way Completely Randomize Design (CRD) with 4 treatment and 4 replication. The treatment were tried such as:
T_0 : goat meat *dendeng* without *Lactobacillus plantarum*
T_1 : goat meat *dendeng* with 0.3 mL *Lactobacillus plantarum*
T_2 : goat meat *dendeng* with 3 mL *Lactobacillus plantarum*
T_3 : goat meat *dendeng* with 30 mL *Lactobacillus plantarum*
The formulation of fermented goat dendeng with *Lactobacillus plantarum* can be seen on Table 2

Table 2. Tabulation Data

Treatment	R_1	R_2	R_3	R_4
T_0	T_0R_1	T_0R_2	T_0R_3	T_0R_4
T_1	T_1R_1	T_1R_2	T_1R_3	T_1R_4
T_2	T_2R_1	T_2R_2	T_2R_3	T_1R_4
T_3	T_3R_1	T_3R_2	T_3R_3	R_3R_4

Table 3. Ingredients and Composition of Fermented Goat *Dendeng*

Ingredients	Total			
	T_0	T_1	T_2	T_3
Goat meat	150 grams	150 grams	150 grams	150 grams
Lactobacillus plantarum	0	0.3 mL	3 mL	30 mL
Salt	3 grams	3 grams	3 grams	3 grams
Brown sugar	25 grams	25 grams	25 grams	25 grams
Garlic	7.5 grams	7.5 grams	7.5 grams	7.5 grams
Galangal	1 grams	1 gram	1 gram	1 gram
Cumin	0.25 gram	0.25 gram	0.25 gram	0.25 gram
Pepper	0.5 gram	0.5 gram	0.5 gram	0.5 gram
Coriander	2 grams	2 grams	2 grams	2 grams

Source: Veerman, et. al (2013) with modification

3.3.1. Procedure of goat meat *dendeng* making

Purchased the goat meat and then milled it. weighed the spices and then smoothed. mix the meat with spices, stirred it until evenly distributed. Divided the dough into 4 (four) according to treatment. inoculated with starter *Lactobacillus plantarum* according to the treatment used consist of 0 mL, 0.3 mL, 3 mL, and 30 mL. Wrap the *dendeng* dough with aluminium foil. Put it into incubator 37℃ for 24 hours. mold the dough using glass with thickness of 3 (three) milimeters. Dry it using oven with temperature

40℃ for 9 (nine) hours. Wait until the *dendeng* in normal temperature for 15 minutes before packed and labeled. This process can be seen on Figure 5.

3.3.2. Propagation of *Lactobacillus plantarum*

The process of propagation *Lactobacillus plantarum* were inoculated pure culture as much 1 (one) ose wire into *deMan Rogosa Sharp* Agar (MRS-A), then incubated at 37℃ for 48 hours and ready for use as working cultures to make starter. The remainder was stored at -4℃ as culture stock. *deMan Rogosa Sharp Broth* (MRS-B) sterile as much as 5 ml inoculated with working culture as much as 1 (one) ose wire the incubated at 37℃ for 48 hours to obtain liquid culture. The liquid culture inoculate as much as 1% into a 50 ml skimmed milk which was sterile and incubated at 37℃ for 24 hours to obtain the parent starter. The bulk starter was prepared by 1% parent starter inoculated with skimmed mil 50 ml and glucose or sugar 3 grams for 24 hours at temperature at 37℃ for 48 hours with SPC (Standard Plate Count) method. The flowchart can be seen on Figure 6.

3.3.3. Variables

The variables for this research were pyschochemical test (fat and cholesterol level), microbiology test (Total Plate Count), and organoleptic (texture, aroma, and taste). The procedure analysis of all variables presented in Appendix 1 – 6.

3.3.4. Data Analysis

The data from this research was tabulated with Microsoft Excel and statistical analysis that used was ANOVA (Analysis of Variance). If the data obtained significant difference, it would be followed to DMRT (Duncan Multiple Range Test).

The Completely Randomized Design mathematical model is:

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

Notes:

Y_{ij} = observation of the main factors
μ = general average
τ_i = primary effect on level to-i
ε_{ij} = influence of error
I = 1, 2, 3, 4.....a
J = 1, 2, 3, 4.....u

3.3.5. Terminology

Goat Meat	:	meat that has a paler color that sheep meat (mutton) and has white color on the fat part.
Intermediate Moisture Food	:	food product that has water content between 10 – 50%, Aw (activity water) between 0.6 – 0.9, and elastic texture that allows to formed, and longer shelf life compared to other foods.
Dendeng	:	slashed or ground meat, seasoned with spices, and dried with sunlight or low heat.
Lactobacillus plantarum	:	homofermentative bacteria that can be able to break down complex compound into simple compound with the end result is lactic acid.
Fat Content Analysis	:	analysis to identify fat content of food product with soxhlet method, using extration tools such as condenser, eletric heater, and petroleum ether solution.
Cholesterol Content Analysis	:	analysis using the Lieberman Burchard method, cholesterol hydrolised by concetrated H_2SO_4 releases OH groups which will react with acetic acid anhydride in red, green, blue.

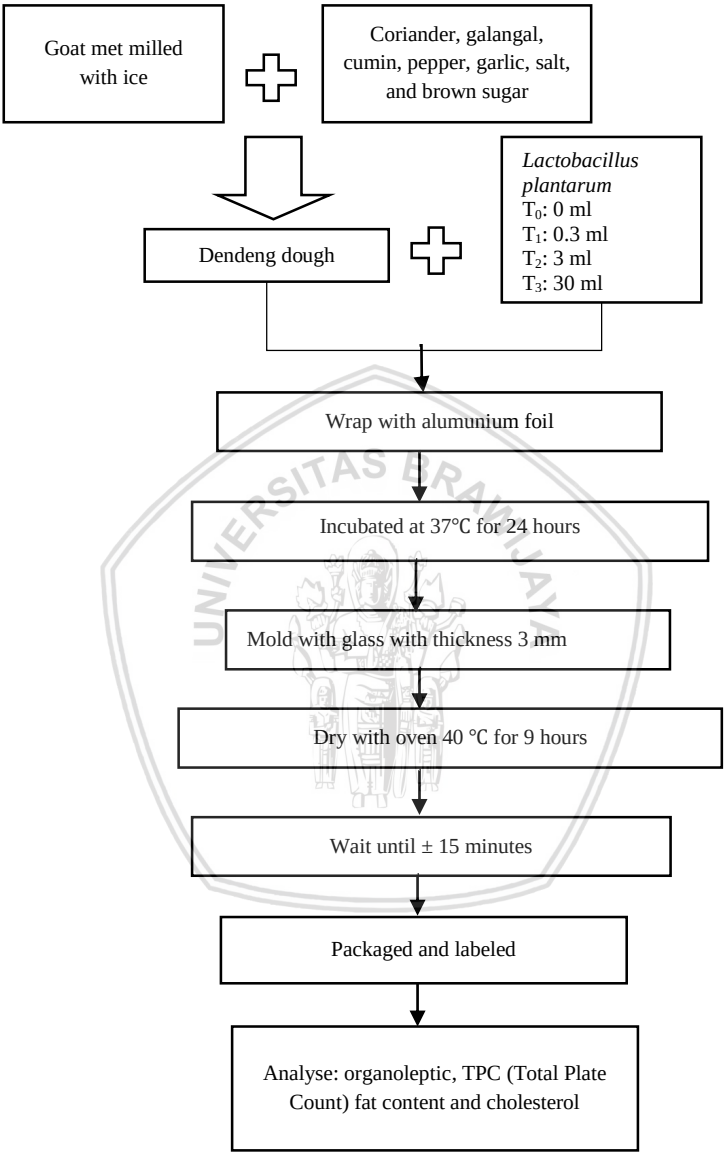

Figure 5. Propagation of *Lactobacillus Plantarum* (Setioningsih, Setyaningsih, and Susilowati, 2004)

CHAPTER IV
RESULTS AND DISCUSSIONS

4.1. Performance and Quality of Fermented Goat Meat *Dendeng*

Fermented goat meat *dendeng* was traditional food made from goat meat that milled with ice and mixing with the spices and *Lactobacillus plantarum*. The spices were salt, palm sugar, garlic, galangal, coriander, cumin, and pepper. *Lactobacillus plantarum* as starter had a function to reduced fat and cholesterol and repaired the quality of organoleptic. According Elfirah, Rahmatu, and Nilawati (2015) fish *dendeng* was traditional food mixed with spices and had a better value if there was modification to improve the good prospect. The probiotic cultures had easily cultivated, provide longer shelf life, and contributed to the quality of sensory for the final product (de Macedo, Pflanzer, and Gomes, 2012)

The process of fermented goat meat dendeng were meat grinding, mixing with the spices, lactic acid bacteria inoculation, incubation for 24 hours, drying with oven. According to de Macedo, Pflanzer, and Gomes (2012) the process of meat fermented product were grinding of raw materials, weighing the raw materials and spices, preparing the starter cultures, mixing, fermentation, drying, and packaging.

The qualitative characteristics of fermented goat meat *dendeng* had quite sour taste, quite tender, reddish-brown color, and distinctive aroma. The comparison between fresh dendeng were brown color, tender textue, and typical beef aroma. Reported by Arief, Suryati, and Maheswari (2006) Dark Firm Dry that fermented by *Lactobacillus plantarum* had very tender texture. Sour taste

from lactic acid was the final product of carbohydrate metabolism by lactic acid bacteria (Setyorini, Arifin, and Nurwantoro, 2010)

Cholesterol and fat content of fermented goat dendeng was decreased by the activity of *Lactobacillus plantarum*. Some of microbes could reduced the cholesterol content (Brown and Goldstein, 1991). *Lactobacillus plantarum* produced lipase enyzme that had lypolytic activity to catalyze the fat into fatty acid and gliserol (Dinzer and Kivanc, 2017; Nisa and Wardani, 2016). The effect of fermented goat meat dendeng was represented on Table 4.

(a) T_0 (a) T_1 (a) T_2 (a) T_3

Figure 6. Fermented Goat Meat Dendeng

Table 4. The Effect of Fermented Goat Meat *Dendeng* on Fat, Cholesterol, and TPC

Treatment	Variables		
	[B]Fat Content (%)	[B]Cholesterol content (mg)	[A]TPC (log cfu/g)
T_0	7.83±0.69[b]	79.06±0.24[c]	4.95±0.21[a]
T_1	7.61±1.23[b]	77.18±0.50[b]	5.25±0.88[a]
T_2	4.69±1.53[a]	77.06±0.23[b]	5.52±0.14[ab]
T_3	3.48±0.70[a]	75.65±0.41[a]	6.34±0.56[b]

Notes: Value are means of 4 replicates± SD; [A] Means with different letter differ significantly ($P<0.05$); [B]Means with different letter differ significantly ($P<0.01$). T_0 = 0 mL *Lactobacillus plantarum* T_1 = 0.3 mL *Lactobacillus plantarum* T_2 = 3 mL *Lactobacillus plantarum* T_3 = 30 mL *Lactobacillus plantarum*

4.2. Fat Content of Fermented Goat Meat *Dendeng*

Fat had some function such as improve the appearance and physical structure of food, and improve nutritional value and calories. But, excessive fat consumption will lead to coronary heart disease and obesity. The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat *dendeng* had a highly significant effect ($P<0.01$) on fat content. The statistical analysis was in Appendix 7. The result of the analysis of the fat content of the fermented goat meat dendeng showed that the control treatment T_0 was not significantly different to T_1 (addition of *Lactobacillus plantarum* 0.3 mL) but significantly different ($P\leq0.01$) to T_2 (addition of *Lactobacillus plantarum* 3 mL) and T_3 (addition of *Lactobacillus plantarum* 30 mL). Treatment of T_2 (addition of *Lactobacillus plantarum* 3 mL) was not

significantly different with T_3 (addition of *Lactobacillus plantarum* 30 mL). The highest fat content value at T_0 is 7.83% while the lowest in T_3 is 3.48%. The addition of *Lactobacillus plantarum* in the manufacture of fermented goat meat dendeng proven decreased fat content.

The fat content produced by the T_0 compared with T1 (addition of *Lactobacillus plantarum* 0.3 mL) showed no significant difference. The lactic acid that produced by *Lactobacillus plantarum* to assist the process of lipolysis with the amount of 0.3 mL and control treatment was not sufficient to reduced the fat content of fermented goat meat dendeng. The resulting fat content of T_2 treatment (addition of Lactobacillus plantarum 3 mL) compared with T_3 (addition of Lactobacillus plantarum 30 mL) showed no significant difference. The increasing amount of Lactobacillus plantarum used, the activity of lipolysis on lactic acid would work well. This was in accordance with the statement of Tamime and Robinson (1999) that the hydrolysis of fat by starter cultures occurs only at a limited rate.

Fat content of fermented goat meat dendeng in all of treatment suitable with the requirement as food product. Food stuff that had a good quality could provide sufficient nutritional value. According to Surhayanto (2007) explained that lamb dendeng had fat content 8.87% and pork *dendeng* had 6.07 – 18.72%. Fat content of goat meat by Composition Table of Indonesian Food from Mahmud, Hermana, Zulfianto, Rozanna, Apriyantono, Ngadiarti, Hartati, Bernadus, and Tinexcelly (2009) was 9.20%, compared to fermented goat *dendeng* from this research the highest fat content was 7.83%.

4.3. Total Plate Count (TPC) of Fermented Goat Meat *Dendeng*

Total Plate Count (TPC) was one of microbiology analysis to determine the microbiological quality. This analysis can be used as indicator of the quality and shelf life of food products (Mailoa, Sabahannur, and Halid, 2013). The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat *dendeng* had given no significant effect ($P>0.05$) on Total Plate Count. The statistical analysis was in Appendix 8. The result of Total Plate Count (TPC) of fermented goat meat dendeng showed that T_0 was not significantly difference to T_1 (addition of *Lactobacillus plantarum* 0.3 mL) and T_2 (addition of *Lactobacillus plantarum* 3 mL) but significantly different ($P\leq0.05$) with T_3 (addition of *Lactobacillus plantarum* 30 mL). Treatment of T_3 (addition of *Lactobacillus plantarum* 30 mL) was not significantly difference to T_2 (addition of *Lactobacillus plantarum* 3 mL) (Table 4). The highest Total Plate Count (TPC) value on T_3 is 6.34 log CFU/g while the lowest at T0 is 4.95 log CFU/g. The addition of *Lactobacillus plantarum* in the manufacture of fermented goat meat dendeng proved the total number of bacteria increased.

The average value of Total Plate Count ranged from 5.34 – 5.80 log CFU/g. The lowest Total Plate Count was obtained from the treatment with the addition of *Lactobacillus plantarum* 30 mL (T_3) as much 5.34 log CFU/g and the highest value obtained from the treatment with the addition of *Lactobacillus plantarum* 0.3 mL (T_1) was 5.80 log CFU/g. This was due to the food source for the bacteria was not enough. The lactic acid bacteria unable to live in a medium that containing less carbohydrates. Reported by Widodo, Sulistiyanto, and Utama (2015) the

main nutrient to lactic acid bacteria was carbohydrate. Carbohydrate was used as source of energy and metabolism. Carbohydrate was used by lactic acid bacteria to formed lactic acid.

Fermented goat meat dendeng with *Lactobacillus plantarum* could increased the Total Plate Count (TPC) and got significantly different result ($P \leq 0.05$) compared with the control treatment. The increase of Lactobacilus plantarum improved the number of bacteria that contained in fermented meat goat dendeng. The Total Plate Count (TPC) produced by T0 treatment compared with T_1 and T_2 showed no significant difference. The energy intake for survival of *Lactobacillus plantarum* has not been sufficient. Reported by Widodo, Sulistiyanto, and Utama (2015) the main nutrients for lactic acid bacteria are carbohydrates. Carbohydrates are used as a source of energy and metabolism. Carbohydrates are used by lactic acid bacteria to form lactic acid.

Vuyst and Vandamme (1994) reported that lactic acid bacteria produced organic acids such as acetic acid and lactic acid will inhibit the growth of *E. Coli* and *Salmonella*. The ability of *Lactobacillus plantarum* was produce antimicrobial compound, that was hydrogen peroxide. Nowroozi, Mirzaii, and Norouzi (2004) explained that the activity of lactic acid bacteria in the good food product was produced bacteriocin and antimicrobial as organic compound to inhibited the growth of pathogen, such as *Lactobacillus plantarum* was produced H_2O_2 to inhibited the growth of *Salmonella*. Mechanism of lactoperoxidase and thiocyanate, hydrogen peroxidase could reduced the permeability structure molecules to inhibited the growth of *Salmonella*, *Staphylococcus*, and *E. Coli* (Jenie and Rini, 1995). According to Hugas and Monfort (1996)

Lactobacillus plantarum was one of strains able to produced bacteriocins which are antimicrobial compound. Bacteriocins was against sensitive bacteria and prevent the outgrowth of food pathogens.

The Total Plate Count (TPC) produced by the T_0 compared with T_1 and T_2 showed no significant difference. T_2 compared with T_3 showed no significant difference. The number of viable bacterial cells of *Lactobacillus plantarum* was unknown. The Total Plate Count method analyzes all types of non-bacterial specific bacteria. Muthmainah, Suradi, and Yurniati (2016) stated that the Total Plate Count method analyzes all bacteria in the product and can not separate lactic acid or non-lactic acid.

4.4. Cholesterol Content of Fermented Goat *Dendeng*

Cholesterol content could influenced by nutritional intake from food of fat source. The increasing of fat consumption as much 100 mg/day could be increase cholesterol as much 2 – 3 mg/dl. Cholesterol content in the body beyond the normal requirement could create hypercholesterolemia. Hypercholesterolemia could improve the risk of atheroschlerosis, heart and kidney disease (Yani, 2015). Cholesterol in the body was from endogenous and exogenous. Exogenous cholesterol was cholesterol material that synthesized by food from outside the body. Endogenous cholesterol was cholesterol from inside the body that synthesized in some tissue, especially in liver (Putra, Saraswati, Isdadiyanto, 2016). The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat dendeng wasn reduced highly significant ($P<0.01$) on cholesterol content. The statistical analysis was in Appendix 9. The results showed that T_0 control treatment was significantly different ($P\leq0.01$) to T_1

(addition of *Lactobacillus plantarum* 0.3 mL), T_2 (addition of *Lactobacillus plantarum* 3 mL), and T_3 (addition of *Lactobacillus plantarum* 30 mL). Treatment of T_1 (addition of *Lactobacillus plantarum* 0.3 mL) was significantly different ($P \leq 0.01$) with T_3 (addition of *Lactobacillus plantarum* 30 mL) but not significantly difference with T_2 (addition of *Lactobacillus plantarum* 3 mL). The addition of *Lactobacillus plantarum* in the manufacture of fermented goat meat dendeng proven decreased cholesterol levels.

Cholesterol levels produced by T_1 (addition of *Lactobacillus plantarum* 0.3 mL) compared with T_2 (addition of *Lactobacillus plantarum* 3 mL) showed no significant difference. The amount of *Lactobacillus plantarum* was not fully able to bound the cholesterol in the bacterial cell wall product and the amount of cholesterol in each different product before fermentation. This was consistent with the statement (Usman and Hosono 1999: Ziarno, Ewa, and Alvaro, 2010) that the amount of cholesterol bound in different cells and the presence of peptidoglycanic structures in bacterial cell walls that have various amino acid compositions in each type of bacteria in their role binding the cholesterol.

Increased levels of *Lactobacillus plantarum* in fermented goat meat dendeng could reduced cholesterol levels. *Lactobacillus plantarum* had ability to decreased the cholesterol content in the body and the food by inhibited the synthesized of cholesterol thereby cholesterol production would decreased (Fadhilah, Hafsan, and Nur, 2015). *Lactobacillus plantarum* had some of mechanism to reduce cholesterol such as binding the cell walls, enzymatic deconjugation, combination of cholesterol during the growth of celular membranes, inhibit the HMG CoA reductase, and precipitation of cholesterol (Khiralla, 2015).

Research reported by Kimoto, Ohmomo, and Okamoto (2002) cholesterol was removed by *Lactobacillus plantarum* when attached into the cell surface, which was physical phnemenon and have a relation with cell wall. Possible mechanism that occured was cells was done cholesterol assimilation. According to Tok and Belma (2010) if the cells dead because it was heated, it still could remove cholesterol from the medium by binding the cholesterol to cell. Some of microbes could produce compound that could inhibited, mobilized, and reduced the cholesterol content (Brown and Goldstein, 1991).

Reported by Kuppusamy and Kumar (2005) isolated *Lactobacillus plantarum* from cow milk had decreased cholesterol. Yu, et. al (2013) reported isolated *Lactobacillus plantarum* from Chinese sauekraut can be potential probiotic to reduced the cholesterol. Lactic acid bacteria were generally used in fermentation industry as health bacteria to produce good fermentation product. Lactobacillus was genus that conluded in lactic acid bacteria. Lactic acid was produced organic acids as main products that could reduced cholesterol. Organic acids that produced were glucoric acid, folic acid, and lactic acid (Hardiningsih and Nurhidayat, 2006).

4.5. Organoleptic evaluation of fermented goat meat *dendeng*

Organoleptic value was obtained from panelist preference. Panelists was given score from a product with their human senses (taste, color, texture, and aroma). In this research, sensory evaluation used 30 panelists from animal science students at Brawijaya University. *Hedonik* test was one of organoleptic analysis to know the response of consumer about the product. The analysis result showed that

the addition of *Lactobacillus plantarum* with different amount on the fermented goat *dendeng* gave a highly significant effect (P<0.01) on texture, a significant effect on aroma (P<0.05), and no significant effect (P>0.05) on taste. The average value of organoleptic can be seen in Table 5.

Table 5. The Effect of Fermented Goat Meat *Dendeng* on Organoleptic

Treatment	Taste	Aroma[A]	Texture[B]
T_0	3.39±0.88	3.33±1.01[b]	3.16±1.10[b]
T_1	3.51±1.10	3.43±1.09[b]	2.93±1.06[a]
T_2	3.63±0.96	3.38±0.99[b]	3.18±1.10[b]
T_3	3.48±1.07	3.07±1.07[a]	2.74±1.06[a]

Notes: Value are means of 4 replicates± SD; [A] Means with different letter differ significantly (P<0.05); [B]Means with different letter differ significantly (P<0.01). T_0 = 0 mL *Lactobacillus plantarum* T_1 = 0.3 mL *Lactobacillus plantarum* T_2 = 3 mL *Lactobacillus plantarum* T_3 = 30 mL *Lactobacillus plantarum*

4.5.1. Texture

Texture was a characteristic of a material as a result of the combination of several physical properties including size, shape, and elements of material information that can be felt by the sense of touch, taste, and eyesight. This characteristic was important to obtain the consumer preference (Midayanto and Yuwono, 2014). The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat dendeng had highly significant effect (P<0.01) on texture. The texture of fermented goat meat dendeng in T_0 control treatment was significantly different (P≤0.01) to T_1 (addition of

Lactobacillus plantarum 0.3 mL) and T_3 (addition of *Lactobacillus plantarum* 30 mL) but not significantly different with T_2 treatment (addition of *Lactobacillus plantarum* 3 mL). Treatment of T_1 (addition of *Lactobacillus plantarum* 0.3 mL) was significantly different with T_2 (addition of *Lactobacillus plantarum* 3 mL) but not significantly different with T_3 (addition of *Lactobacillus plantarum* 30 mL). The highest texture value of fermented goat meat dendeng on T_2 was 3.18 while the lowest on T_3 (addition of *Lactobacillus plantarum* 30 mL) is 2.74 (Table 2). The higher of value, texture of fermented goat meat dendeng would be more tender.

The increasing of *Lactobacillus plantarum* was made fermented goat *dendeng* more tender. Goat meat dendeng that more tender (T_3) unliked by the panelist. Fermented goat *dendeng* would be more tender than without *Lactobacillus plantarum*. *Lactobacillus plantarum* produced proteolytic enzyme that can degrading the muscle fibers. Peptide bonds of amino acid in complex protein was broken down by proteolytic enzymes. Degradation of amino acids was influenced by lactic acid bacteria through their fermentation process could improve texture (Fadda, Lopez, and Vignolo, 2010).

The texture produced by T_1 treatment (addition of *Lactobacillus plantarum* 0.3 mL) compared with T_3 (addition of *Lactobacillus plantarum* 30 mL) showed an unreal difference. The texture produced by the control treatment compared with T_2 (addition of *Lactobacillus plantarum* 3 mL) showed no significant difference. Some panelists had some different texture preferences due to the ability of human teeth in different chewing. According to Soeparno (2009) the impression of softness includes the texture of the panelists that involves 3 (three) aspects, the

initial ease of penetration of the teeth into the meat, the two ease of chewing the meat into smaller pieces, and the amount of residue left behind after mastication.Veerman, et. al (2013) stated that the result of texture was addition of spices in the process of making dendeng. The texture of meat product was affected by the type of meat, processing method, and material that used. The additional material like sugar, salt and etc could affect texture. Texture of dendeng affected by the appearance and impression that given from human senses.

4.5.2. Aroma

Aroma was stimulus from food that felt from odor and received by the olfactory organ. Aroma was product characteristic that the impression came from smell. The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat dendeng had a significant effect ($P<0.05$) on aroma. Fermented goat meat dendeng in control treatment was not significantly different with T_1 (addition of *Lactobacillus plantarum* 0.3 mL) and T_2 (addition of *Lactobacillus plantarum* 3 mL). Treatment of T_3 (addition of *Lactobacillus plantarum* 30 mL) was significantly different ($P\leq0.05$) with control treatment, T_1 (addition of *Lactobacillus plantarum* 0.3 mL), T_2 (addition of *Lactobacillus plantarum* 3 mL). The highest fermented goat meat dendeng value of T1 (*Lactobacillus plantarum* 0.3 mL addition was 3.43 whereas the lowest in T3 (addition of *Lactobacillus plantarum* 30 mL) was 3.07 (Table 2) .The higher value produced, the aroma would more distinctive.

Panelist assessment of the aroma of fermented goat meat dendeng from T_0, T_1, and T_2 was no significant difference. The value obtained is 3.33 - 3.43 which means

had a distinctive aroma of dendeng. *Lactobacillus plantarum* that used in high or low amount was quite change the aroma of original dendeng. Aroma from meat and and spices that mixed strongly combined with the addition of *Lactobacillus plantarum*. Panelists were difficult to differentiate and to described because the aroma are almost same. The aroma of spices and goat meat was combined. Aroma was too difficult to determined objectively. According to Husna, Asmawati, and Suwarjana (2014) aroma value of Leubiem fish dendeng could not differentiate by the panelist because it had almost same aroma.

The high assessment of fermented goat meat dendeng to T_3 was significantly different with all treatments, because Lactobacillus plantarum has an important role in the fermented goat meat dendeng aroma. It made the spices have a strong tasty aroma. Research by Nisa and Wardani (2016) aroma which was developed from the fermented sausage because there was Maillard reaction. Maillard reaction was occured because reaction between amino groups and sugar reducer from fermentation process. Through Strecker degradation, Maillard reaction was produced aroma's compound that tasty caused by formed of furfural and maltol compound.

4.5.3. Taste

Taste was stimulus from food that felt by the tongue. Taste was one of component to measure the quality of product although from nutritional aspect only gave small effect but it was determined the consumer preference (Veerman, et al, 2013). The analysis result showed that the addition of *Lactobacillus plantarum* with different amount on the fermented goat dendeng had no significant effect ($P>0.05$) on taste. The value of taste was between 3.39 –

3.51. According to panelists, the highest value was obtained by (T_1) goat *dendeng* with addition of 3 mL *Lactobacillus plantarum* as much 3.51 (sour) and the lowest value was obtained by (T_0) goat *dendeng* control treatment 3.39 (quite sour). The overall average value of taste from fermented goat dendeng was 3.5 (sour). The panelist was prefered to T_1 because the goat meat dendeng had a unique taste and suitbale with the customer preference.

Lactobacillus plantarum that used in high amount would affected the taste of fermented goat dendeng. Half of the panelist liked the taste. Sour taste from the bacteria unliked by the other panelist. But some of panelists was not like the taste of the control treatment because the taste was as well as dendeng with the other meat. Panelists was not found something unique about the taste.

Fermented food that had sour taste was still foreign for Indonesian people. The other research by Nisa and Wardani (2016) the fermentation process caused by the proteolytic bacteria. Some compound was degraded such as protein became amino acids and peptide. Amino acids was flavor compounds precursor because amino acid was converted became small compound and caused spesific flavor. Nisa and Wardani (2016) explained that acid total was increased because of pH was decreased. It can be conclude that some of people was not liked the food that had sour taste.

4.6 The Best Treatment

4.6.1. Non organoleptic

The best treatment from non organoleptic aspect (fat, cholesterol, and Total Plate Count) was obtained on T_3. The fat content was 3.48%, the cholesterol content was 75.65 mg, and the total plate count was 6.34 log cfu/g. This

treatment with the addition of *Lactobacillus plantarum* 30 mL had the best effect to reduce cholesterol and fat content among others.

4.6.2. Organoleptic

The best treatment from organoleptic aspect (texture, taste, and aroma) was obtained on T_2. The average value of texture was 3.18, aroma 3.38, and taste 3.63. this treatment with the addition of 3 mL had the best effect to increase the quality of organoleptic aspect and best panelist's preference.

CHAPTER V
CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

Based on the result of research, it could conclude that:

1. Addition of *Lactobacillus plantarum* on fermented goat dendeng showed decreased cholesterol content and fat content; increased the quality of texture and aroma
2. The best treatment from this research was:
   Organoleptic aspect: T_2 (*Lactobacillus plantarum* 3 mL)
   Non-organoleptic aspect: T_3 (*Lactobacillus plantarum* 30 mL)

5.2. Suggestions

- The further research was needed to be done with other culture to fermented goat *dendeng*
- Conduct a microorganism population count before using the bulk starter.